"EXPRESS MAIL" MAILING LABEL
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APPLICATION FOR PATENT
FOR
SHOT DIRECTION INDICATION DEVICE

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BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to the field of oil and gas well services. More specifically, the present invention relates to an apparatus that provides positive indication of orientation of perforating guns disposed within a wellbore.

2. Description of Related Art

The orientation of perforating guns is the subject of many prior art patents. These patents include Daniel, U.S. Patent No. 4,410,051, Kitney, U.S. Patent No. 5,273,121, George, U.S. Patent No. 4,637,478 and Edwards, U.S. Patent No. 5,964,294. Orienting perforating guns in deviated wells enables the well operator to aim the shaped charges of the perforating gun at specific radial locations along the circumference of the wellbore. This is desired because the potential oil and gas producing zones of each specific well could exist at any radial position or region along the outer wellbore circumference. These potential producing zones around the deviated well dictate the desired orientation of a perforating gun to ensure that the shaped charges perforate the casing adjacent a potential producing zone.

Because perforating guns are often thousands of feet below the surface of the earth during the perforation process, it is difficult to determine if the perforating gun is in the desired orientation at the instant the shape chargers are detonated. Knowing the orientation of the perforation gun during detonation can be useful to the well operators. If the gun is not in the desired orientation, adjustments can be made to the tool so that it is properly oriented in subsequent operations.

Alternatively, if the perforating gun was well out of the orientation tolerances when the well was perforated, the possibility exists of sand entering the wellbore. Having knowledge of potential sand production due to errant shaped charge position, the well operators could consider corrective action to address errant perforations. The corrective action includes gravel packing operations to curb any sand production and possibly shutting off the sand producing portion of the wellbore and drilling an alternative bore around that section. Because these operations are very expensive the well operators must have reliable evidence of perforation shot orientation before undertaking such corrective action. Accordingly there currently exists a need by which the actual orientation of the perforating gun can be readily discerned from a quick examination of the perforating gun after the perforation process.

BRIEF SUMMARY OF THE INVENTION

One embodiment of the present invention discloses an apparatus for use in more effectively placing perforations in a hydrocarbon producing wellbore comprising an elongated housing formed for axial insertion into said wellbore. The elongated housing includes one or more shaped charges disposed within and an indicator mechanism created from a deformable material. The indicator mechanism is secured within the elongated housing and formed to comprise an annulus therein. The annulus has an inner surface and an outer surface that form opposing sides and the annulus axis is parallel to the elongated housing axis. Disposed within the annulus is an indicator element that is freely moveable within the annulus, such that upon rotation of the elongated housing the indicator element responds to gravitational forces and moves along the annulus to a location closest to the source of the gravitational forces. The opposing sides of the annulus are malleable and deformable and can be squeezed together to secure the indicator element between the opposing sides locking it

into a stationary position. Because the stationary position is the low point of the annulus, analysis of the downhole tool after it is retrieved from the wellbore can reflect the orientation of the downhole tool when the opposing sides were squeezed together. One way in which the sides can be squeezed together is by detonation of a detonation cord placed close to the axis of the inner surface which in turn urges the inner surface against the outer surface thereby trapping the indicator element between the opposing sides at the point where the annulus is at its lowest.

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BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING.

Figure 1 illustrates a partial cut away of a downhole tool including the shot orientation indication device.

Figure 2 illustrates a cross-sectional view of the indicator mechanism.

Figure 3 depicts a cross-sectional view of a perforating gun including the indicator mechanism.

Figure 4 depicts an overhead view of a locking nut.

DETAILED DESCRIPTION OF THE INVENTION

With reference to the drawing herein, a shot orientation indication device according to one embodiment of the present invention is shown in Figure 1. The cross sectional view of Figure 1 illustrates the indicator mechanism 20 co-axially situated within a downhole tool 10. The downhole tool 10 can be any device used in subterranean well operations, including perforating guns, logging devices, or any other device adapted for operations in a well bore. Further, the downhole tool 10 is

capable of being used with a wireline, a tractor sub, or can be tubing conveyed. With respect to the present invention, the downhole tool 10 has an elongated housing 11 and includes shaped charges (not shown).

The indicator mechanism 20 is comprised of a generally circular inner surface surrounded by an also circular outer surface 23. The combination of the inner surface 22 surrounded by the outer surface 23 creates an annulus 21 between the two opposing surfaces. Disposed within the annulus 21 is an indicator element 24. The respective sizes of the annulus 21 and the indicator element 24 are such that the indicator element 24 can freely move about the entire circumference of the annulus 21 in either a clockwise or a counter-clockwise direction.

As shown in Figures 1 and 3, the indicator mechanism 20 further comprises an upper surface 26 and a lower surface 25. The combination of these four surfaces operates to create an annulus 21 that fully encloses the indicator element 24. However, alternative embodiments of the indicator mechanism 20 exist. These include shapes where the inner surface 22 and the outer surface 23 have top and bottom ends that are curved toward the opposing surface member to provide a support or containment means for the indicator element 24. As shown in the accompanying figures though, the inner surface 22 and the outer surface 23 are substantially cylindrical and have a radius that is much larger than the length of the cylinder.

The inner surface 22 should be comprised of a material having a modulus of elasticity of sufficient magnitude to resist deformation when being coupled with the downhole tool 10, as well as when the downhole tool 10 is being inserted into a wellbore, including deviated wellbores. Additionally, the material of the inner surface 22 should be sufficiently ductile and tough to be

plastically deformed without suffering catastrophic failure. Accordingly, the preferred material for the inner surface 22 is brass, but it could also be made from other malleable materials such as carbon steel, stainless steel, or copper.

The indicator element 24 should be manufactured from a highly elastic and hard material to enable it to freely revolve around the annulus 21 with a minimum amount of rolling resistance. Therefore it is preferred that the indicator element 24 be formed from stainless steel, but it can also be made from other materials having high coefficients of elasticity coupled with high Brinell hardness values. Similarly, because the indicator element 24 traverses the surface of the outer surface 23, the outer surface 23 should be constructed of a hard, yet elastic material. Preferably the outer surface 23 material is stainless steel, but other hard elastic materials could be used as well.

In the accompanying figures the indicator mechanism 20 is illustrated as being coaxial within the down hole tool 10. But the indicator mechanism 20 can be located at various locations within the down hole tool 10 inside of its elongated housing 11, as long as the axis of the indicator mechanism 20 is parallel to the axis of the down hole tool 10.

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In Figure 3 a detonation cord 35 is shown which acts as a fuse to detonate the shaped charges contained within the elongated housing 11. The detonation cord 35 is activated on one end and transfers the energy along its length to the shaped charges (not shown) where they in turn are detonated by the detonation cord 35 for perforating the sides of a well bore. The detonation cord 35 can be comprised of such as Primacord®. It should be noted that while Figure 3 illustrates a perforating gun having ~~a swivelled~~ action 40, the present invention can be used in downhole tools

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Sub A2 ~~that have a single segment, as well as multiple segments that are connected~~ together such as the one depicted ~~in Figure 3~~.

The lock down nut 30 depicted in Figures 3 and 4 is shown to be threaded on an outer surface, and secured into the down hole tool 10. Sufficient tightening of the lock down nut 30 secures the indicator mechanism 20 within the down hole 10. It is well understood that the design parameters for creating the lock down nut 30 should be obvious to one skilled in the art.

In operation the downhole tool 10 containing the indicator mechanism 20 would be assembled at surface before insertion of the down hole tool 10 into a well bore. When the downhole tool 10 reaches the deviated section of the wellbore, it should begin to rotate until it is in its desired orientation as prescribed by the design of the downhole tool 10. During this time the inner and outer surfaces (22, 23) of the indicator mechanism 20 will rotate as well, thereby altering their angular position within the wellbore. However, the indicator element 24, which is not secured to either the inner or outer surface (22, 23) will move with respect to both surfaces and ultimately come to rest at the lowest point within the annulus 21.

In the case where the down hole tool 10 is a perforating gun, upon detonation of the detonation cord 35 a shock wave is produced of sufficient force to deform the inner surface 22 and impinge it against the outer surface 23. The material of the inner surface 22 deforms outward against the outer surface 23 and impinges the indicator element 24 securely in place against the outer surface 23. This location is the low point of the annulus 21 at the time of detonation. After the tool is retrieved from the well bore, examination of the position of the indicator element 24 with respect

to the rest of the perforating gun, provides the well bore operators an indication of where the perforating charges were oriented when the shaped charges were detonated.

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The present invention described herein, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein. While a presently preferred embodiment of the invention has been given for purposes of disclosure, numerous changes in the details of procedures for accomplishing the desired results. Such as the utilization of non-metallic materials in the construction of the elements of the indicator mechanism 20. These and other similar modifications will readily suggest themselves to those skilled in the art, and are intended to be encompassed within the spirit of the present invention disclosed herein and the scope of the appended claims.